REMARKS

The Office Action of September 22, 2004 has been received and its contents carefully considered.

Claims 3 to 15 are all the claims pending in the application, prior to the present amendment.

Claims 3, 6, 8 and 13 have been rejected under 35 U.S.C. § 103(a) as obvious over Dickson et al in view of the newly cited U.S. Patent 4,614,692 to Kajiyama et al. See Paragraph 4 of the Office Action.

Applicants submit that Dickson et al and Kajiyama et al do not disclose or render obvious the presently claimed invention and, accordingly, request withdrawal of this rejection.

As set forth in claim 3 as amended above, the present invention is directed to gas diffusion porous carbon sheet for a solid polymer fuel cell which comprises a carbon fiber woven fabric that is obtained by firing in a non-oxidizing atmosphere a cellulose-based woven fabric in a temperature range of 900 to 3000°C, and which has a thickness in the range of 0.05-0.4 mm, a volume resistivity of less than 0.2Ω•cm in the layer direction, and a gas permeability of not less than 1500/cc/cm^2/hr/mmAq, and wherein the electrical resistance in the direction of thickness of the woven fabric is no greater than 50 mΩ•cm^2 as measured between two copper plates with a load of 4 kgf/cm^2.

Thus, applicants have amended claim 3 to incorporate the recitations of claim 8 which has now been cancelled. Applicants have amended the remaining claims under examination to reflect this amendment to claim 3. In addition, applicants have amended claim 7 to define the water repellant property. Support for this amendment can be found in Table 2, at page 21 of the specification.

The carbon fiber woven fabric employed in the gas diffusion carbon sheet of the present invention has a sufficient mechanical strength and an excellent conductivity in the direction of the thickness (layer transverse direction) of the woven fabric, which is particularly useful for a solid polymer fuel cell. A carbon fiber woven fabric having an electrical resistance in the direction of the thickness of the carbon fiber woven fabric as in the present invention has not been known in the prior art.

The Examiner's rejection is similar to the Examiner's previous rejection of the claims based on Dickson et al, except that the Examiner now relies on the teachings of the newly cited Kajiyama et al patent which shows that a porous graphite substrate for a fuel cell can have a thickness of about 0.1 to 2 mm, at column 4, lines 55 to 61. The Examiner argues that it would have been obvious to make the carbon cloth of Dickson et al with a thickness between 0.1 and 2 mm in order to create a carbon cloth that could be used in a fuel cell as taught by Kajiyama et al.

In Dickson et al, the carbon cloth in Example 2 had a thickness of about 0.025 inches, which correspond to 0.635 mm, which is above the 0.05 to 0.4 mm range recited in claim 1. The

carbon cloth in Example 2 of Dickson et al was obtained as a result of shrinkage and loss of weight during the process disclosed in Dickson et al.

Applicants submit that there is no teaching or suggestion that one of ordinary skill in the art should adjust or would be able to adjust the process parameters of Dickson et al to obtain a conductive cloth that had a lower thickness of less than that disclosed in Example 2 of Dickson et al.

Kajiyama et al discloses a porous fuel cell electrode made of graphite, but do not disclose the features of the present invention as defined in claim 3.

Dickson et al mention graphitized carbon made from phosphorous-and-metal-containing organic nonconductive materials (organic polymeric celluloses of rayon fibers), but that is all. Dickson et al do not disclose or teach that a gas diffusion porous carbon sheet for a solid polymer fuel cell having the specific features as stated in claim 3 can be obtained by selecting a specific cellulose-based woven fabric with a specific texture and carbonizing under specific conditions, and that the obtained carbon fiber woven fabric is very suitable as a gas diffusion porous carbon sheet for a solid polymer fuel cell.

Although Kajiyama et al mention that the thickness of a porous substrate of a fuel cell electrode may be from 0.1 to 2 mm, this disclosure in Kajiyama et al is set forth only a general range which can be used for an electrode. Kajiyama et al do not disclose or teach that a carbon fabric woven fabric can be made which has such a thickness.

Kajiyama et al disclose that the porous electroconductive substrate of graphite can be made from a number of different materials including carbon fiber, carbon fiber woven fabric and carbon powder. In Kajiyama et al, Examples 1, 3, 5 and 6 employed a carbon fiber non-woven fabric, Examples 2, 4 and 7 employed a carbon fiber woven fabric, Examples 8 and 9 employed a graphite powder, Example 10 employed a graphite plate and Example 11 employed a graphite powder. The only mention of thickness in these Examples occurs in Examples 5 and 6, where the thickness of the carbon fiber non-woven fabric before graphitization was 0.8 mm and 1.2 mm, respectively. Both of these thicknesses are not within the claimed range of 0.1 to 0.4 mm, and do not indicate the thickness of the graphitized carbon non-woven fabric. Further, these thicknesses do not provide any information concerning the thickness of a carbon fiber woven fabric.

In view of the above, applicants submit that Kajiyama et al do not teach and would not have led one of ordinary skill in the art to a thickness of 0.1 to 0.4 mm for a fired carbon fiber woven fabric as recited in the present claims.

As can be seen from the above discussion, Kajiyama et al and Dickson et al do not provide a gas diffusion porous carbon sheet of a solid polymer-type fuel cell having the combined specific features of the present invention as defined in claim 3.

Further, Dickson et al and Kajiyama et al do not disclose or suggest the orientation recited in claims 4 or 5. Accordingly, applicants submit that these claims provide an additional basis for patentability.

Further, by selecting a woven fabric having a specific vertical orientation, for example, as stated in claim 4, in addition to the other conditions, the features as defined in claim 3 can be obtained, which was not known.

With respect to the remaining recitations in the claims, the Examiner's position is similar to that in the previous Office Action.

In the Amendment Under 37 C.F.R. § 1.116 that was filed on April 8, 2004, applicants presented a number of arguments against the Examiner's inherency position. The Examiner has not addressed any of those arguments in the present rejection. For the reasons stated in that Amendment, applicants submit that the carbon cloth of Dickson et al does not have the properties set forth in the present claims.

In view of the above, applicants submit that Dickson et al and Kajiyama et al do not disclose or render obvious the subject matter of the present claims and, accordingly, request withdrawal of this rejection.

Claims 3, 6, 8, 18 have been rejected under 35 U.S.C. § 103(a) as obvious over the newly cited U.S. Patent No. 3,723,610 to Fischer et al, in view of the newly cited Kajiyama et al patent and, alternatively, in further view of the newly cited U.S. Patent No. 3,577,705 to Sharlit.

Applicants submit that claims 3, 6, 8 and 18 are patentable over Fischer et al, Kajiyama et al and Sharlit.

In essence, the Examiner asserts that Fischer et al disclose, at column 2, lines 4 to 9, a cellulose-based carbon fiber fabric that is pyrolyzed at a temperature of 2000 to 3000°C. The

Examiner states that Fischer et al do not teach the thickness of the fabric, but relies on the teachings of Kajiyama et al, at column 4, lines 51 to 61, for a thickness of a porous fuel cell diffusion layer between 0.1 and 2 mm. The Examiner argues that it would have been obvious to employ such a thickness in Fischer et al.

In addition, the Examiner argues that with respect to the other recitations in the present claims, such as, volume resistivity, gas permeability, compressive strength and electrical resistance, it is reasonable to presume that these recitations are satisfied by Fischer et al because Fischer et al employ similar materials, that is, cellulose-based woven fabrics, in a similar production process, that is, firing at a high temperature in a non-oxidizing atmosphere to create a carbon fabric. The Examiner states that the burden is upon applicant to prove otherwise.

In addition, the Examiner states that, alternatively, it would have been obvious to create a fabric with the claimed properties as a matter of optimization. The Examiner points out that the newly cited Sharlit patent discloses that cellulose-based carbon fabrics may obtain higher conductivities by increasing heating time, as disclosed at column 2, line 60 to column 3, line 1. The Examiner argues that it would have been obvious to adjust the initial fabric structure and processing conditions in Fischer et al to obtain the recited properties, since it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art.

In response, applicants disagree with the Examiners' characterization of Fischer et al.

Thus, Fischer et al do not relate to treating a cellulose-based carbon fiber fabric at column 2, lines 4 to 9. The disclosure in Fischer et al at column 2, lines 4 to 9 relates to treating or

pyrolyzing a condensed substance that is made by a copolymerization of vinyl chloride and at least one material selected from the group consisting of polyvinyl alcohol and derivatives of polyvinyl alcohol which are crossed-inked by treatment with acid condensation agents until they become unmeltable at pyrolysis temperature. In fact, at column 2, lines 9 to 11, Fischer et al clearly state that the treatment that they are describing at column 2, lines 4 to 9, is in comparison with the treatment of cellulose articles. Accordingly, applicants submit that the entire basis for the Examiner's rejection is in error.

Further, with respect to the Examiner's reliance on Kajiyama et al for a thickness recitation, applicants refer the Examiner to applicants' above discussion of Kajiyama et al in the preceding rejection. As can be seen from that discussion, applicants submit that Kajiyama et al do not teach and would not have led one of ordinary skill in the art to a thickness of 0.1 to 0.4 mm for a fired carbon woven fabric as recited in the present claims.

With respect to the Examiner's inherency argument, applicants submit that this argument is without foundation since Fischer et al do not use similar materials, that is, Fischer et al do not use a cellulose-based woven fabric. Thus, applicants submit that the Examiner is not correct that the process described in Fischer et al would inherently result in the recitations of the present claims. Inherency exists only when the process disclosed in the prior art necessarily and always produces the same result. In the present case, the Examiner is merely guessing that the same result may be obtained because "similar" materials and processes allegedly were employed. This is insufficient to support an allegation of inherency.

Further, Fischer et al do not disclose or suggest the orientation recited in claims 4 or 5. Accordingly, applicants submit that these claims provide an additional basis for patentability over Fischer et al.

Further, with respect to the Examiner's assertion that it would have been obvious to create a fabric with the claimed properties as a matter of optimization, applicants submit that more than mere optimization is involved. There has to be some teaching that the recited properties should be optimized. The cited prior art does not discuss these properties and, therefore, does not suggest their optimization.

The present claims recite an electrical resistance in the direction of the thickness of the woven fabric. The cited prior art has not discussed the electrical resistance in the direction of the thickness of the woven fabric, and has not provided any teaching or disclosure which would enable one to produce such a claimed resistance.

With respect to the Examiner's reliance on Sharlit, applicants submit that Sharlit does not appear to teach the electrical resistance in the direction of the thickness of the woven fabric. Accordingly, it appears that there is no teaching or suggestion in Sharlit to obtain the electrical resistance set forth in claim 3.

In view of the above, applicants submit that the cited prior art does not defeat the patentability of claims 3, 6, 8 and 18 and, accordingly, request withdrawal of this rejection.

Claims 3, 6, 8 and 13 to 15 have been rejected under 35 U.S.C. § 103(a) as obvious over the newly cited patent to Millington et al in view of Kajiyama et al and, alternatively, in view of Sharlit. See Paragraph 6 of the Office Action.

Applicants submit that claims 3, 6, 8 and 13 to 15 are patentable over Millington et al, Kajiyama et al and Sharlit and, accordingly, request withdrawal of this rejection.

The Examiner argues that Millington et al disclose a cellulose-based carbon fiber fabric that is fired at high temperature. The Examiner states that Millington et al do not teach the thickness of the fabric, but relies on Kajiyama et al for a teaching of such thickness.

With respect to the recitations of volume resistivity, gas permeability, compressive strength and electrical resistance, the Examiner asserts that these recitations would be inherent in the teachings of Millington since Millington et al employ similar materials and similar production steps. The Examiner asserts that the burden is upon applicants to prove otherwise.

In the alternative, the Examiner asserts that it would have been obvious to create the fabric with the claimed properties as a matter of optimization. The Examiner states that, for example, Sharlit discloses that cellulose-based carbon fabrics may obtain higher conductivities by increasing heating time.

In response, applicants point out that Millington et al is directed to a process for preparing non-graphitic carbon fibers by employing, as a starting material, cellulosic materials which are of the non-thermoplastic type. The cellulose materials can be materials such as cotton, wool and rayon and are usually obtained as fabrics, rovings or yarn, and that a skein of the fabric

may be converted directly to an essentially pure carbon form, or cut into relatively small fabric pieces, and then converted according to the process of Millington et al.

Millington et al do not clearly indicate that the cellulose-based fabric they employ is a woven fabric. In discussing the prior art, at column 1, lines 19 and 20, Millington et al state that reinforcing fibers may be essentially continuous and woven into a textile form or they may be used in short lengths, but Millington et al do not specifically disclose that their starting cellulosic material is in the form of a fabric, roving or yarn is a woven fabric.

With respect to the Examiner's assertions concerning the thickness and the teachings of Kajiyama et al, applicants again refer the Examiner to applicants' above discussion of Kajiyami et al. As can be seen from that discussion, applicants submit that Kajiyama et al do not teach and would not have led one of ordinary skill in the art to a thickness of 0.1 to 0.4 mm for a fired carbon woven fabric as recited in the present claims.

Applicants submit that one of ordinary skill in the art would be led to the thickness recited in the present claims from the combined teachings of Millington et al and Kajiyama et al.

With respect to the Examiner's assertion that Millington et al would inherently achieve the claimed values of volume resistivity, gas permeability, compressive strength and electrical resistance, applicants submit that the Examiner is not correct that the process described in Millington et al would inherently result in the recitations of the present claims. Inherency exists only when the process disclosed in the prior art necessarily and always produces the same result. In the present case, the Examiner is merely guessing that the same result may be obtained

because "similar" materials and processes allegedly were employed. This is insufficient to support an allegation of inherency.

Further, Millington et al and Kajiyama et al do not disclose or suggest the orientation recited in claims 4 or 5. Accordingly, applicants submit that these claims provide an additional basis for patentability.

Further, with respect to the Examiner's assertion that it would have been obvious to create a fabric with the claimed properties as a matter of optimization, applicants submit that more than mere optimization is involved. There has to be some teaching that the recited properties should be optimized. The cited prior art does not discuss these properties and, therefore, does not suggest their optimization.

The present claims recite an electrical resistance in the direction of the thickness of the woven fabric. The cited prior art has not discussed the electrical resistance in the direction of the thickness of the woven fabric, and has not provided any teaching or disclosure which would enable one to produce such a claimed resistance.

With respect to the Examiner's reliance on Sharlit, applicants submit that Sharlit does not appear to teach the electrical resistance in the direction of the thickness of the woven fabric. Accordingly, it appears that there is no teaching or suggestion in Sharlit to obtain the electrical resistance set forth in claim 3.

In view of the above, applicants request withdrawal of this rejection.

In Paragraphs 7, 8 and 9 of the Office Action, claims 4 and 5 have been rejected over the same prior art as set forth in Paragraphs 4, 5 and 6 of the Office Action, and further in view of Fukuda et al.

The Examiner asserts that the primary references do not teach orienting the fibers in the woven fabric as set forth in claims 4 and 5.

The Examiner relies on the teachings of Fukuda et al at column 3, lines 18 to 29 for teaching that when carbon fibers are oriented in the direction of the thickness of the web, the electric and thermal conductivity in the thickness direction is improved.

The Fukuda et al patent is directed to a molded product comprised of a ribbed porous carbon material that contains a ribbed portion and a web portion, in which the carbon fibers in the ribbed portion are oriented in the direction of the thickness of the web portion.

Fukuda et al do not relate to a woven fabric.

Accordingly, Fukuda et al do not teach or suggest to one or ordinary skill in the art that a carbon fiber woven fabric should have the orientation set forth in claims 4 and 5.

Further, claims 4 and 5 depend from claim 3. Accordingly, applicants submit that claims 4 and 5 are patentable for the same reasons as discussed in connection with the rejections of claim 3.

In view of the above, applicants request withdrawal of these rejections.

In Paragraphs 10, 11 and 12 of the Office Action, claim 7 has been rejected over the same prior art as used in Paragraphs 4, 5 and 6 of the Office Action, and further in view of the newly cited patent to Kato.

Claim 7 depends from claim 3. Accordingly, applicants submit that claim 7 is patentable for the same reasons as discussed above in connection with claim 3.

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,

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